Astrophysics At Ames

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Ames Astrophysics Expertise

* Development and Support of NASA Missions
  * Develop & Define new missions (origin of Spitzer, SOFIA, & Kepler)
  * Mission Enabling Technology Development
  * Mission Enabling Laboratory Measurements & Theoretical Calculations
  * Science & Technology support of established Missions
* Laboratory Research in Astrochemistry and Cosmochemistry
  * Photo-chemical synthesis of organic material in simulated ISM and solar system conditions
  * UV/Vis and IR spectral analysis and application to astronomical spectra
* Exoplanet Theory and Observations
* Observational Astronomical Research in Astrobiology and Origins
  * Organic material in the Solar System and Interstellar medium
  * Astrophysics of Galaxies, Stars, Protostars, Stellar Winds, and Circumstellar Disks
  * Expertise in IR observations and instruments

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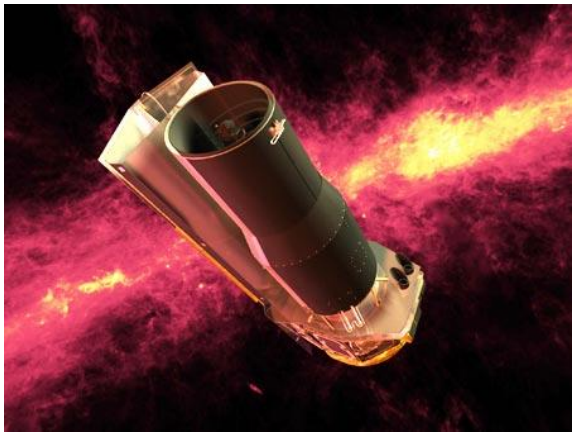
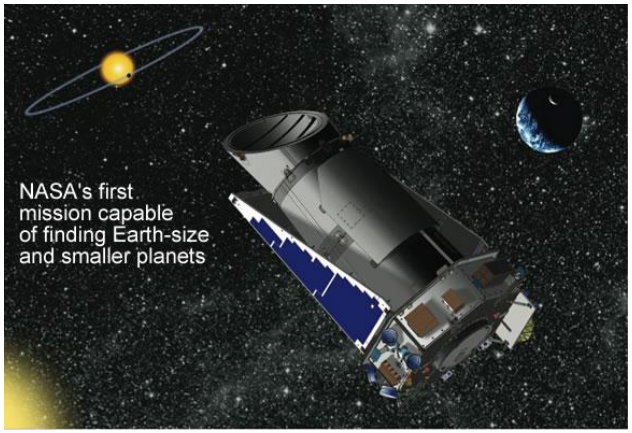
Recent/Current Missions that Originated at Ames



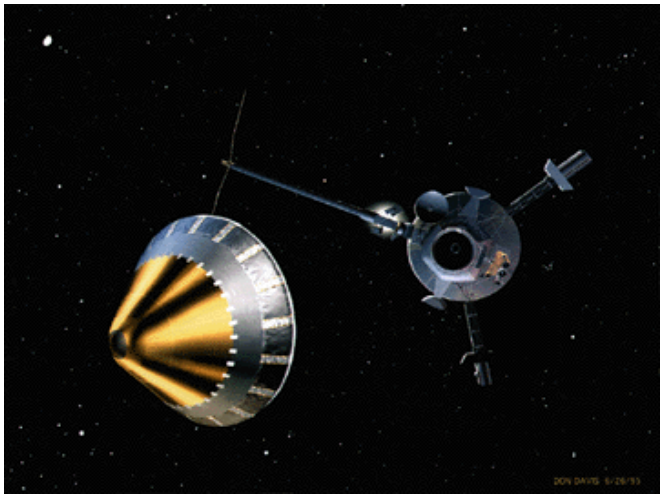
Spitzer Space Telescope



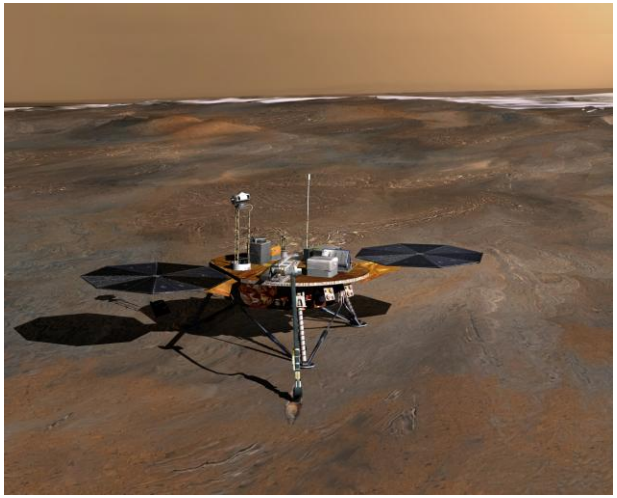
Kepler

SOFIA

LCROSS



Galileo Probe



Phoenix Mars Scout

Ames Astrophysics Capabilities

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Science & Technology Activities on Current Missions

* Spitzer:
  * NASA Facility Scientist and IRS Instrument Deputy PI: Tom Roellig
  * IRAC detector testing & development: Mark McKelvey, Bob McMurray
* JWST:
  * NIRCAM Science Team: Tom Roellig, Tom Greene
  * MIRI Science team: Tom Greene
  * MIRI detector testing: Mark McKelvey, Bob McMurray, Jessie Dotson
* SOFIA:
  * Science Office at Ames
  * NASA Science Instrument Manager: Mike Haas
  * Instrument team members: Sean Colgan, Jessie Dotson
* Stardust:
  * Co-I: Scott Sandford
* WISE
  * Mid-IR detector testing: Mark McKelvey, Bob McMurray, Jessie Dotson
  * Standing Review Board Member: Tom Roellig
* Kepler:
  * PI: Bill Borucki
  * Science Office at Ames
* LCROSS
  * PI: Tony Colaprete
  * Instrument Specialist: Kim Ennico
  * Instrument Design, Construction & Testing
* OSIRIS
  * Co-I: Scott Sandford

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Mission Enabling Activities

Technology Development:

- Infrared Detector Development, Characterization & Radiation Testing (McKelvey et al)
- JWST NIRCam Grism Design & application to exoplanet observations (Greene)
- SOFIA/Forcast Grism Development (Ennico)
- Kepler detector testing & lab simulations (Koch, Witteborn)
- Development of new Phase-Induced Amplitude Apodization Coronographic imaging testbed (Greene)
- Vulcan transit survey ground based telescope (Borucki, Castellano)

Laboratory Measurements & Calculations

- Theoretical Quantum Chemistry (Lee)
- Astrochemistry Laboratory (Allamandola, Salama, Sandford, Mattioda)

Development & Definition of New Missions

- ABE (Sandford et al)
- OSIRIS (Sandford)
- TOPS (Greene)
- Transiting Exoplanet Survey Satellite (Greene)

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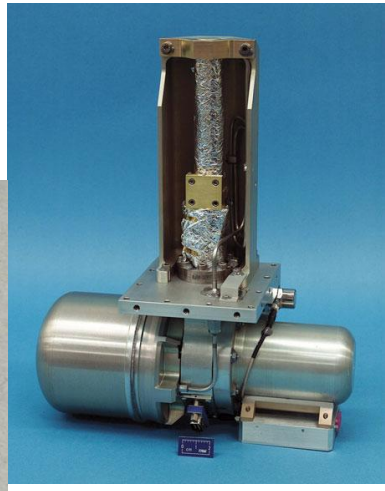
Ames Astrophysics Instrument Technologies

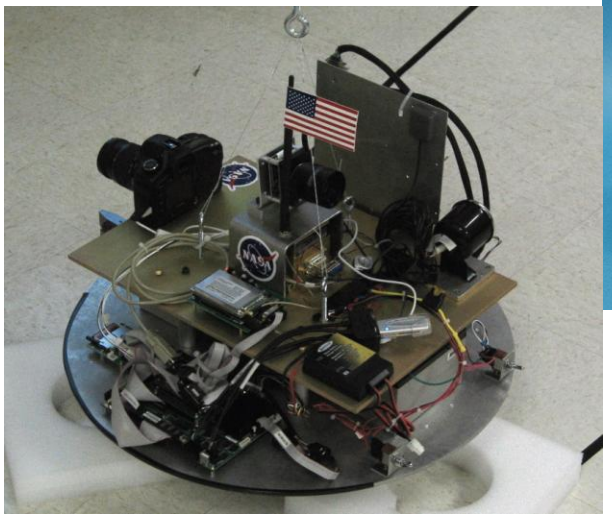
* IR detectors
  * Developed Spitzer and JWST mid-IR detectors with industry
  * Precision detector testing and operation optimization
    * Spitzer, JWST, WISE
  * Premier detector radiation testing lab

QuickTime™ and a
BMP decompressor
are needed to see this picture.

* Cryocoolers
  * Pulse tube closed cycle coolers



* Instrument Development Lab
  * Specialized shop tailored to producing scientific equipment, both rapid prototypes & flight hardware



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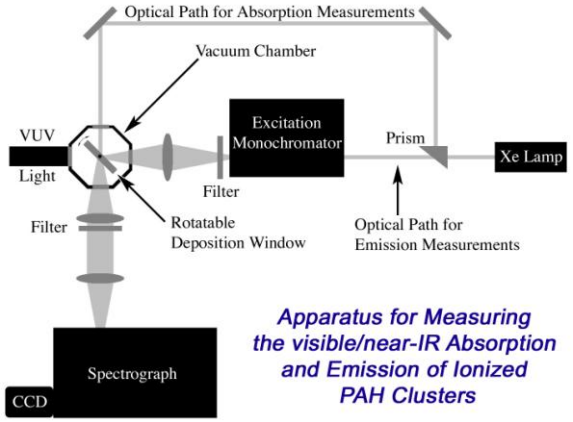
Astrochemistry Lab

Capabilities

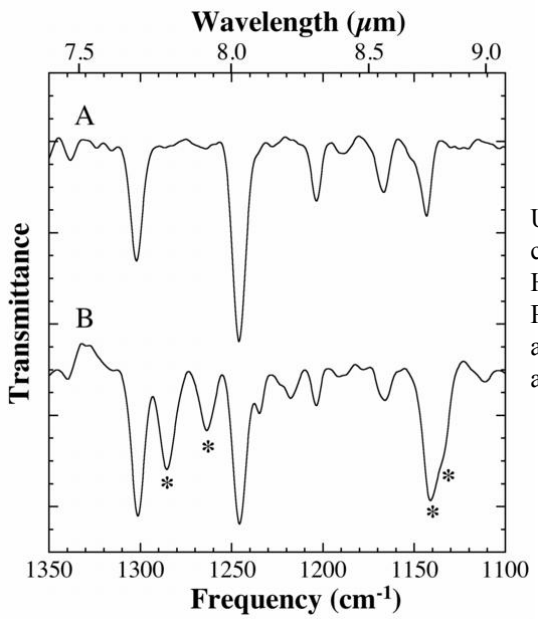
- Suite of high vacuum cryogenic apparati for the preparation of ices and organics & the study of their photochemical evolution
- A range of instrumentation and wet chemical tools for analysis and assay.
- Instrumentation for transmission and reflection spectroscopy from the UV through Far-IR
- Alexandrite, Nd/YAG and dye lasers and associated optical instrumentation for the vaporization, photoluminescence and spectroscopic analysis of materials
- Cosmic Simulation Chamber developed to measure the properties of interstellar, planetary and Lunar dust analogs



Apparatus for Measuring the visible/near-IR Absorption and Emission of Ionized PAH Clusters

Recent Results

- Published lab data showing that PAHs & PANHs exhibit significant absorption in the Near-IR and could be pumped by cool stars.
- Intrinsic band profiles and positions measured in lab allowing searches for specific PAHs (neutrals and ions) in interstellar, circumstellar and planetary spectra.



UV photolysis of PAHs (in this case, neutral phenenthrene, top) in H_2O results in the production of PAH ions, as evidenced by the appearance of their cationic IR absorption features (asterisks).

Ames Astrophysics Capabilities

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Exoplanet Theory & Observations

Exoplanet Theory:

* Model atmospheres of young gaseous exoplanets and brown dwarfs (M. Marley)
* Model atmospheres of gaseous exoplanets, including effects due to stellar irradiation of Hot Jupiters (J. Fortney)
* Modeling the dynamics of multi-exoplanet systems & around binary stars (J. Lissauer)

Exoplanet Observations -- Recent & Future:

* Discovery of 7.5 Me planet in GJ 876 system (Lissauer)
* Vulcan ground based transit observations
* Kepler (Borucki, Koch et al)
* JWST MIRI and NIRCam exoplanet transit observations (Greene)
* www.transitsearch.org -- project to get amateurs involved in finding and characterizing transiting exoplanets (Castellano)

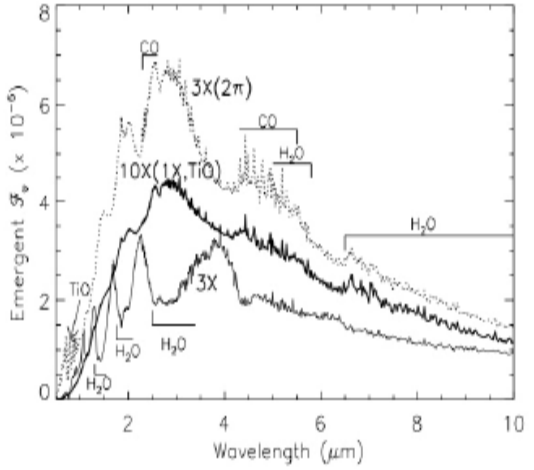
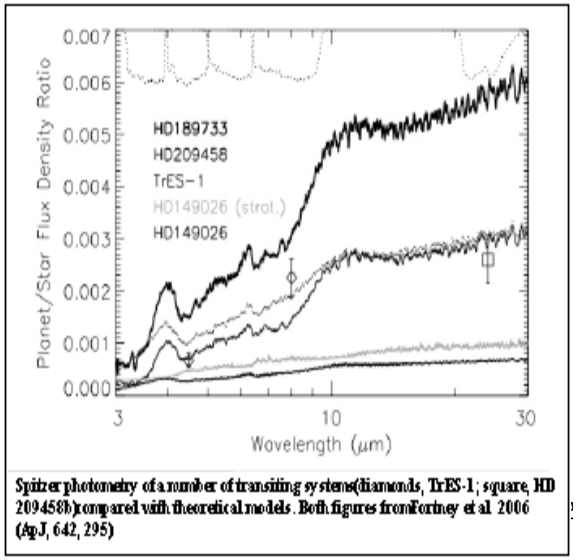


FIG. 3.—Emergent infrared spectra for HD 149026b at [M/H] = 0.5 (labeled 3×), [M/H] = 1.0 with TiO/VO reduced to solar [labeled 10×(1×,TiO)], and [M/H] = 0.5 with 2π sr reradiation (labeled 3×2π). The flux is in ergs s^{-1} cm^{-2}



Spitzer photometry of a number of transiting systems (diamonds, TrES-1; square, HD 209458b) compared with theoretical models. Both figures from Fortney et al. 2006 (ApJ, 642, 295)

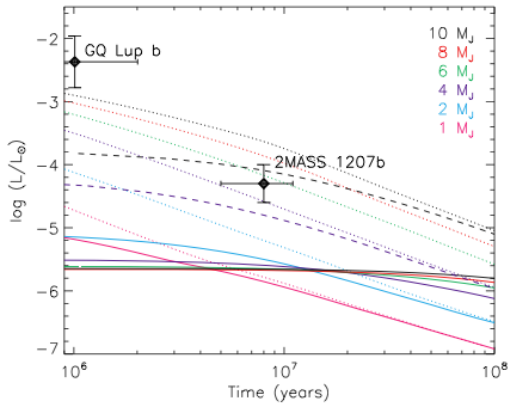


Fig. 6.— Luminosity evolution of various masses for the hot start (dotted), core accretion (solid), and intermediate entropy (dashed) cases. For the intermediate case, only tracks for the 4 and 10 M_J planets are shown. Also shown are the estimated (model dependent) bolometric luminosities of two claimed (Chauvin et al. 2005; Neuhäuser et al. 2005) giant planet mass companions to more massive objects.

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Observational Astronomy

(Primarily IR - submm studies)

* Spitzer
  * Brown Dwarfs, planetary nebulae (Roellig)
  * Kuiper belt objects (Cruikshank, Emery))
  * Dust in elliptical galaxies (Temi, Bregman)
  * Survey of Binary Asteroids (Emery)
  * HII Regions (Rubin)
* Origins of binary stars (Greene)
* Density variations in planetary nebulae (Rubin)
* Protoplanetary Disks (Rubin)
* Planetary studies (Cruikshank)
* Polarization Studies (Simpson, Dotson)
* Galactic Center (Simpson, Colgan, Erickson, Rubin)
* Development of novel computational techniques for clustering analysis of large databases & transient phenomenon

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